Renewable Energy Technologies and Financial Incentives

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Renewable Energy

- Solar (PV, Thermal)
- Hydroelectric Power
- Wind
- Geothermal

Photovoltaic and Solar Hot Water Systems

- Considerations before starting a renewable energy project
- Evaluating energy consumption patterns
- Photovoltaic systems
  - Online tools
  - Site evaluation
- Solar hot water systems
  - Types of solar hot water systems
  - Solar hot water vs. PV systems
  - Special considerations

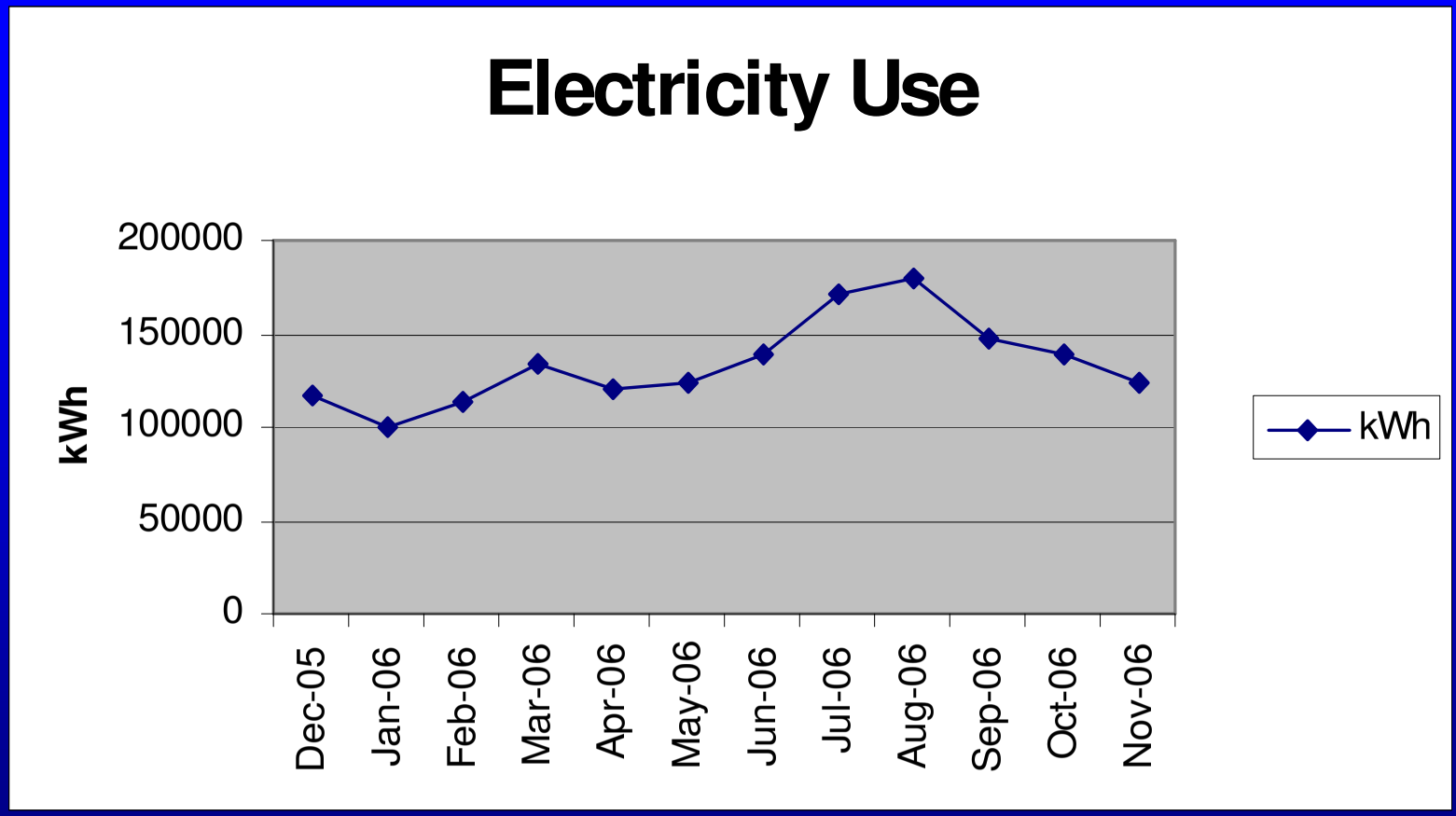
Analyzing Demand & Supply

- How much electricity does the company use?
- Does the company have a % generation goal?
- How many shifts/days does the company operate?
- What does the company's energy demand look like – daily and seasonally?
- Does the utility company assess demand charges?
- Does the company/management have a renewable technology in mind?

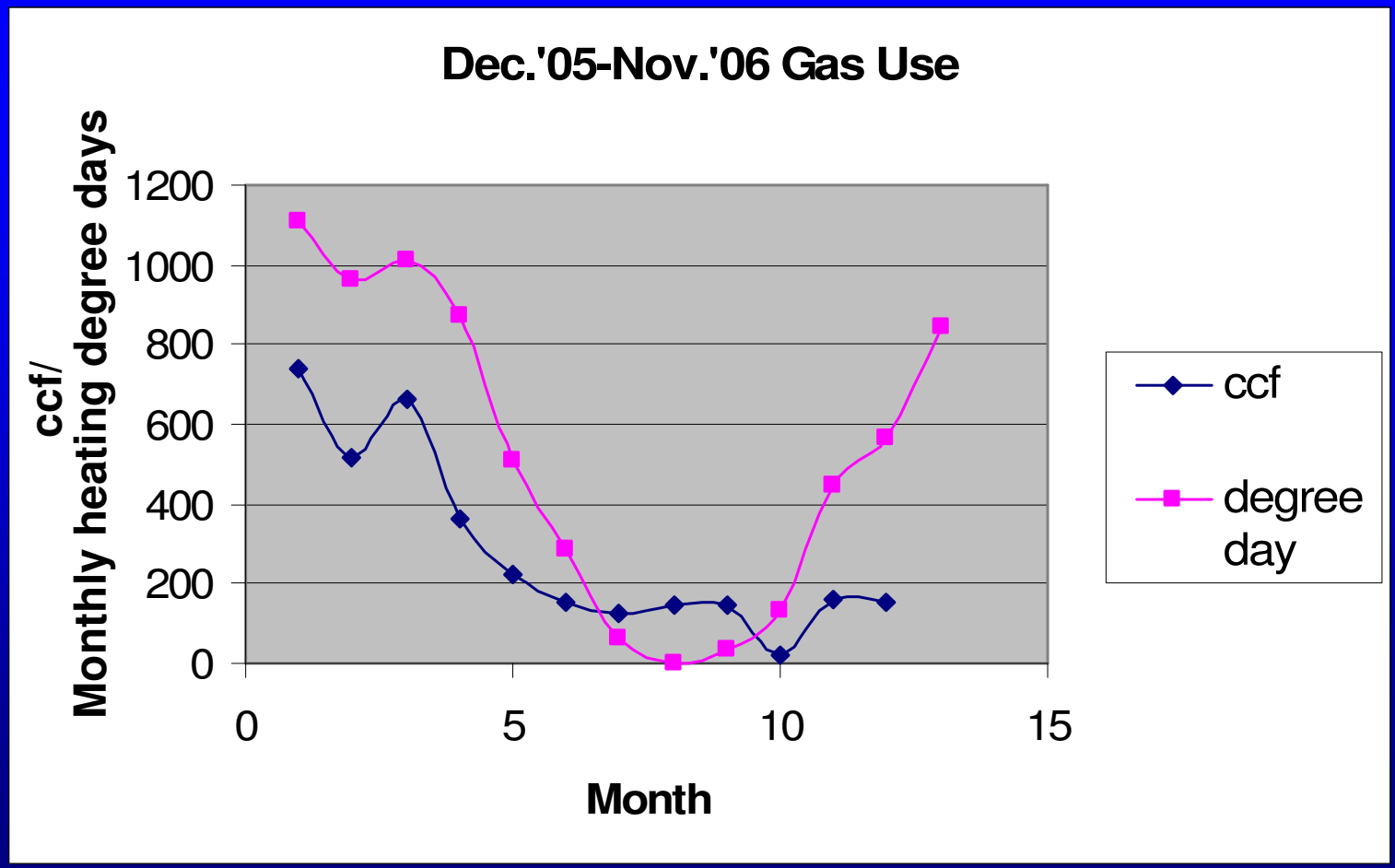
Energy Efficiency

- An energy audit in the past 6 years is generally required for Renewable Energy Trust funding
- Allows for correct sizing of renewable energy system

Graph Energy Use – Electricity



Graph Gas Use – Compare with Temp



PV Watts for Quantifying Solar

- http://rredc.nrel.gov/solar/codes_algs/PVWATTS/version1/

Station Identification:

WBAN Number:	14739
City:	Boston
State:	MA

PV System Specifications:

DC Rating (kW):	60	
DC to AC Derate Factor:	0.77	DERATE FACTOR HELP
Array Type:	Fixed Tilt	

Fixed Tilt or 1-Axis Tracking System:

Array Tilt (degrees):	42.37	(Default = Latitude)
Array Azimuth (degrees):	180.0	(Default = South)

Energy Data:

Cost of Electricity (cents/kWh):	14

Calculate HELP Reset Form

OTA

PVWatts

AC Energy & Cost Savings

Cautions for Interpreting the Results

Station Identification	
City:	Boston
State:	MA
Latitude:	42.37° N
Longitude:	71.03° W
Elevation:	5 m
PV System Specifications	
DC Rating:	60.0 kW
DC to AC Derate Factor:	0.770
AC Rating:	46.2 kW
Array Type:	Fixed Tilt
Array Tilt:	42.4°
Array Azimuth:	180.0°
Energy Specifications	
Cost of Electricity:	14.0 ¢/kWh

Results

Month	Solar Radiation (kWh/m²/day)	AC Energy (kWh)	Energy Value ($)
1	3.36	5014	701.96
2	4.36	5879	823.06
3	4.79	6888	964.32
4	4.92	6685	935.90
5	5.33	7143	1000.02
6	5.41	6763	946.82
7	5.60	7215	1010.10
8	5.65	7325	1025.50
9	5.13	6612	925.68
10	4.65	6422	899.08
11	3.14	4341	607.74
12	2.98	4336	607.04
Year	4.61	74624	10447.36

Output Hourly Performance Data

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Solar PV Issues

- Very diffuse energy source
- Peak resource around mid-day
- Very expensive, Commonwealth Solar funding
- Panel life of ~25 years, but inverter life is typically shorter

Other Considerations

- Generally doesn't supply a large percentage of electricity
- Can lower summer peak demand charges
- Good for companies interested in renewables publicity where wind or hydroelectric are not feasible
- Can contribute to LEED certification

Site Evaluation Survey

- System size and weight
- Foundation Conditions
- Orientation
- Electricity Transmission
- Obstacles
- Roof vs. Ground

Size & Weight

- Area: ~100 ft^2 per kW
- Weight: ~3-5 lbs per ft^2

Therefore…

- An industrial-sized installation of 60kW would be 6000 ft^2 and up to 30,000 lbs

Foundation Condition

Ground

- Concrete piers or slabs for ground-mounted systems w/steel, Al, or wood frame

Roof

- For roof-mounted systems, building must be structurally sound enough to support projected weight
- Recommend installing in conjunction with roof replacement

Orientation

- Solar panels should face south
- SE or SW are also feasible
- Flat installations are common

Optimal Solar Panel Tilt

- www.macslab.com/optsolar.html
- Provides information on optimal tilts for annual or seasonal production
- Company may want to optimize for peak use/to reduce peak demand charges

Electricity Transmission

- Transmitting electricity over a distance causes electricity loss
- PV panels and inverters should be close to the electric meter
- Inverter should be at least within 100 ft of nearest panel – greater than 600 ft can make a project not feasible

Obstacles

- Shading and obstructions must be avoided as much as possible (consider time of day and seasonal variation)
  - Trees
  - Buildings
  - Stacks
  - HVAC equipment
  - Etc.

Roof vs. Ground

- Roof-mounting is generally preferable

Why?

Ground-mounted Installations

- Reduced facility expansion space
- Wetlands
- Zoning issues
- Requires structural support
- Vandalism – fences, security
- Proximity to meter issues

However,

- Installation and maintenance may be easier

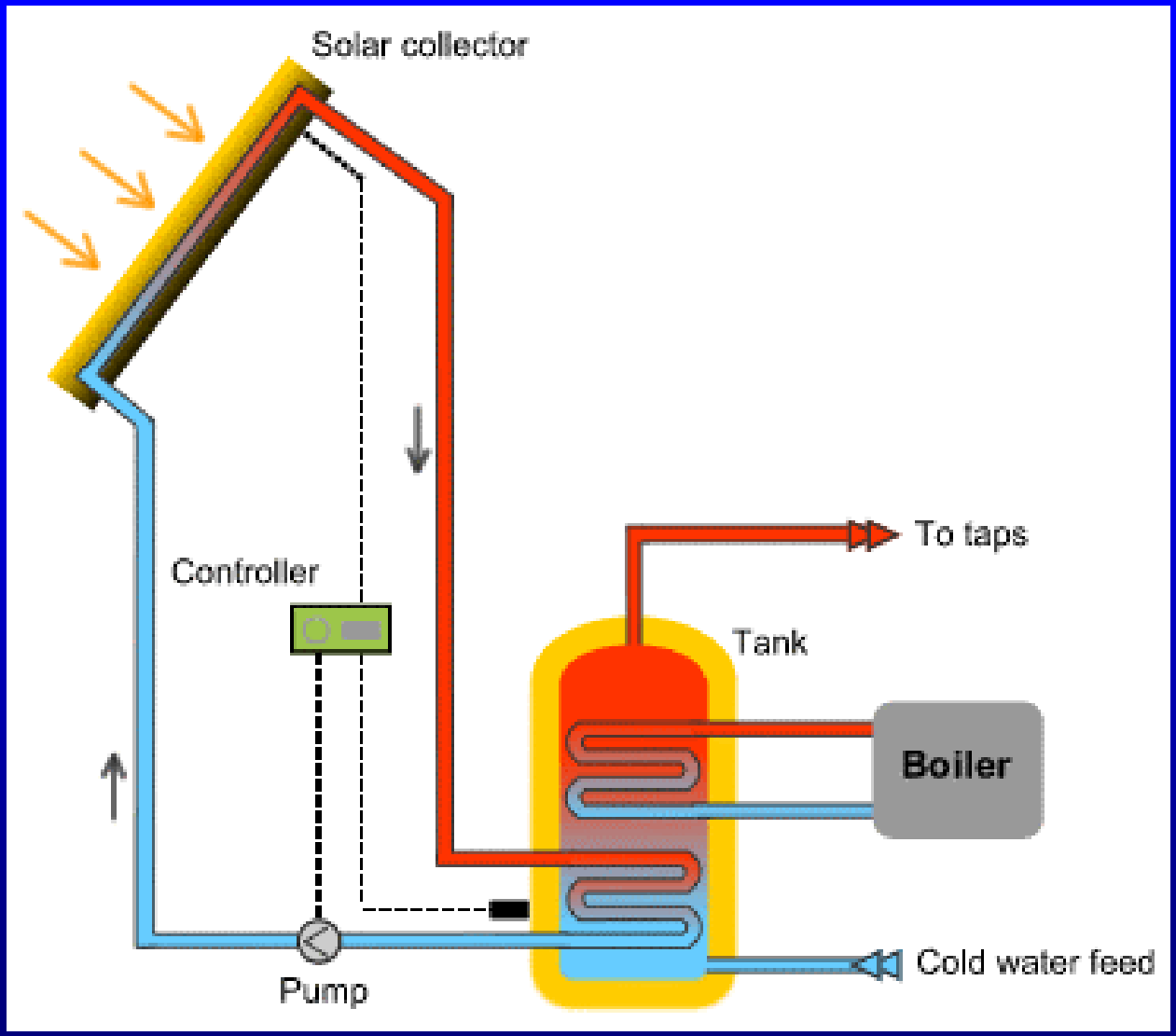
Roof-mounted Installations

- No-cost and often unused
- Zoning issues rare
- Shorter wire runs

However,

- Occasional structural issues
- Complicates re-roofing
- Low roofs preferred – safety & logistics

Solar Hot Water Heating



http://www.west-norfolk.gov.uk/default.aspx?page=22430

Manufacturing

- How does the need for hot water match with what solar hot water would supply?
  - Continuous vs. batch processing
  - Intermittent need?
  - Quantity
  - Centralized vs. decentralized

Flat Plate and Evacuated Tube Collectors

A combination flat plate/evacuated tube solar installation.

http://www.radiantcompany.com/system/solar.shtml

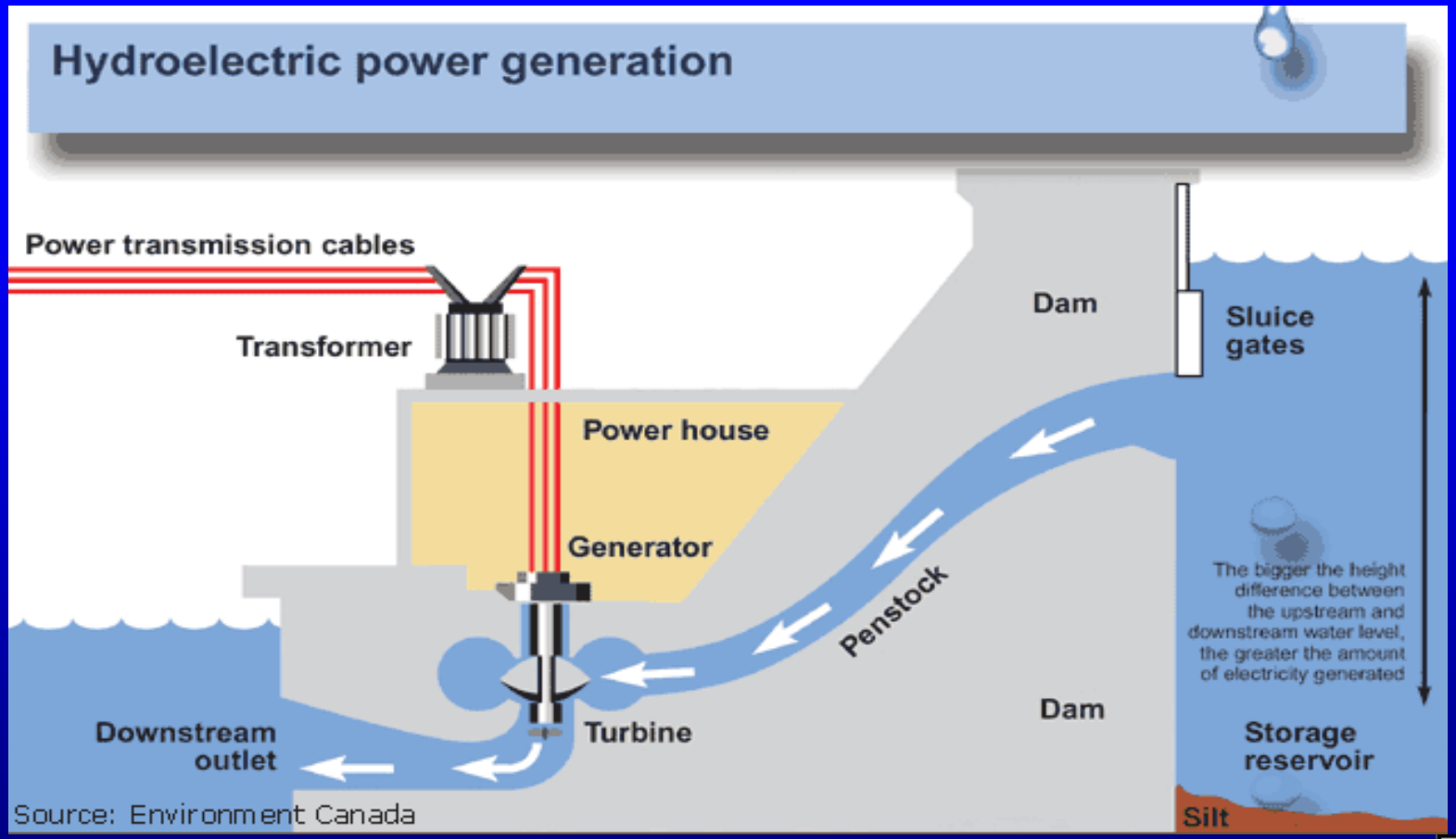
Similarities of the Solars

- Significant weight
- Must face towards sun
- Don’t want shading obstacles
- Transmission losses
- Roof vs. ground issues
- Peak need for energy should roughly coincide with mid-day

Differences between PV and Solar Hot Water

- Much less expensive
- Limited funding offers
  - KeySpan, Bay State, and NSTAR Gas
  - Not RET or Commonwealth Solar
- Additional space needed for large storage tank
- Professionals hard to come by

Hydroelectric Power



http://ga.water.usgs.gov/edu/wuhy.html

Wind Power

LARGE ONSITE RENEWABLE INITIATIVE – 1.5 MW
JIMINY PEAK, MA. (Photo Courtesy of Jiminy Peak)

Wind Power

Small Renewable Initiatives – 2.5 kW Wind Turbine, Oak Bluffs, MA

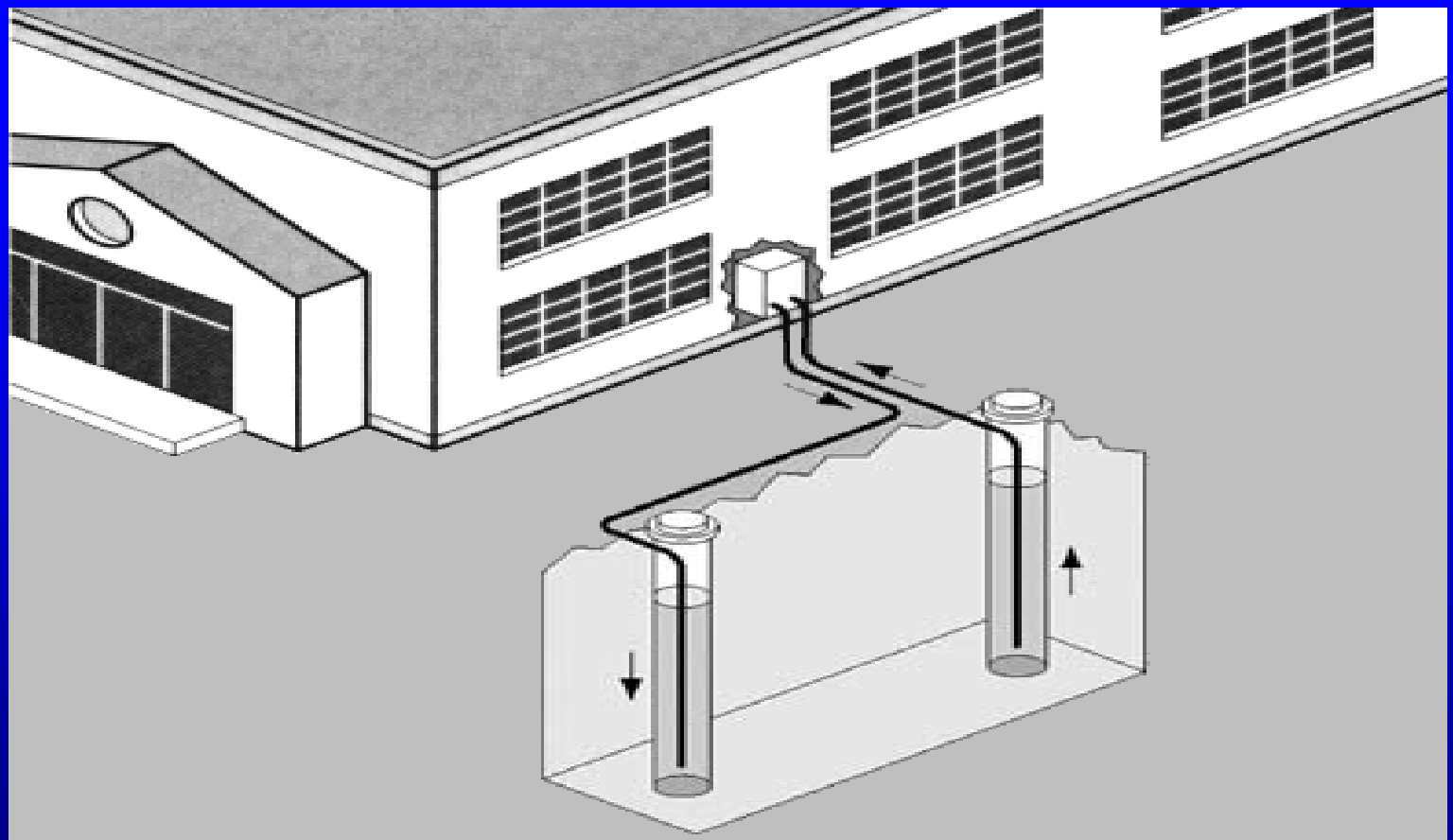
Wind Power Requirements

- Characterize wind resources at the site:
  http://truewind.teamcamelot.com/ne/
  Desired wind speed of at least 14.5 MPH (6.5m/s)
- Estimate latitude and longitude from
  http://www.topozone.com/
- 1,000 feet from the nearest residence
- 5 miles from nearest airport
- Sited at a distance equal to 1.5 times its height from buildings and property lines
- Should not cause more than a 10 dB increase in noise off-site (310 CMR 7.10)

Geothermal Energy

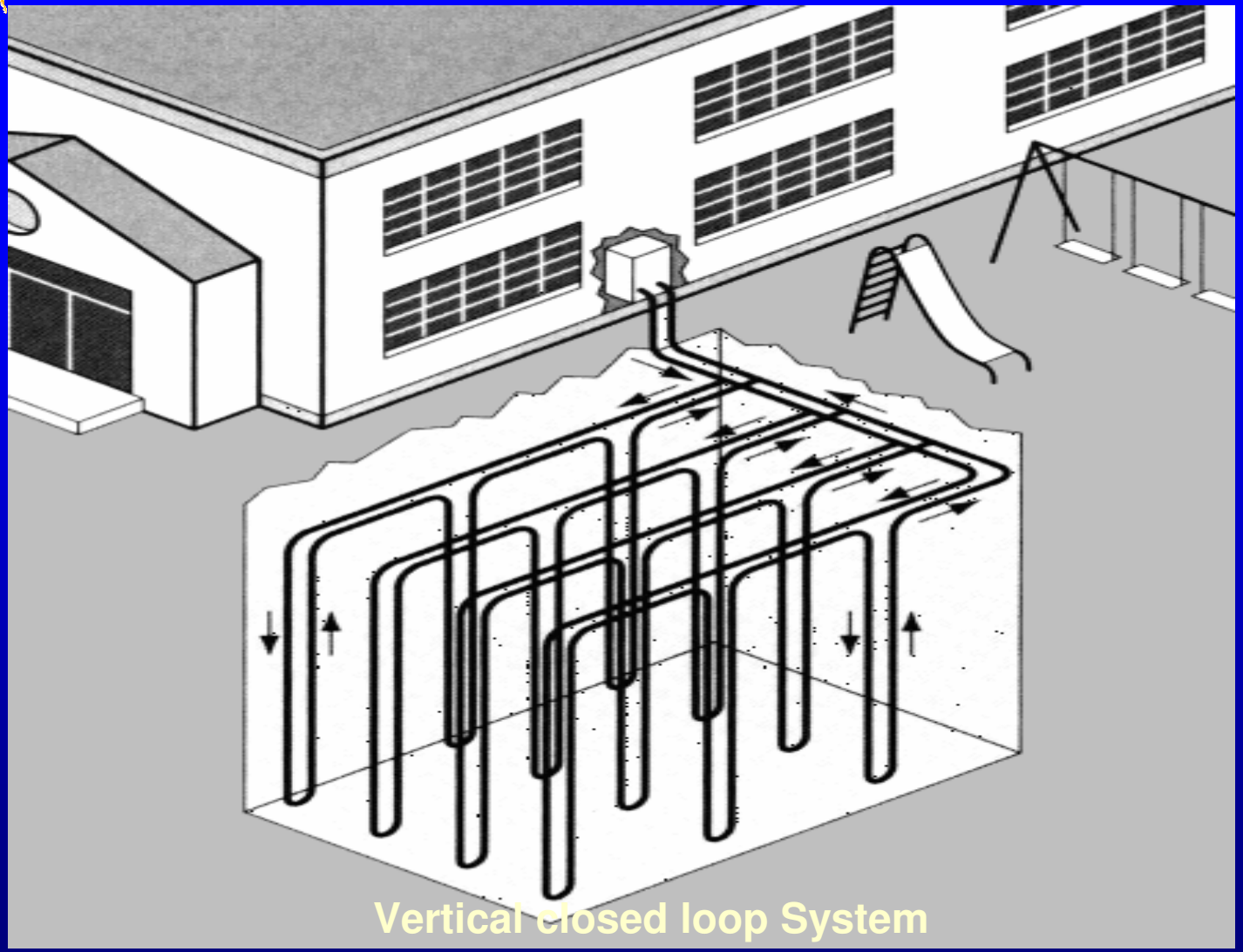
- DIRECT USE – Reservoirs near the surface for residential, commercial and industrial uses
- GEOTHERMAL HEAT PUMP – Use stable water temperature near the surface for space heating, cooling, and for water heating
- POWER GENERATION – Water or steam at high temperatures (300 – 700^{o}F); Reservoirs located one to two miles from the surface

GEOTHERMAL ENERGY



Double-well Open Loop System

GEOTHERMAL ENERGY



Vertical closed loop System

Geothermal in MA

- Public Library, Haverhill MA

  Space conditioning, 6 heat pumps about 35 kW ea., type water to water, $209,000 total cost;1995
- New England Quilt Museum, Lowell MA

  Space heating and cooling, 6 heat pumps about 35 kW ea., type water to water, $215,000 total cost of heat pumps and wells;1995
- High School, Southborough, MA

  Space heating, 704 kW type water to water

Sources:

http://heatpumpcentre.org/publications/

http://www.geo4va.vt.edu/A2/A2.htm

GRANTS

- MTC Large Onsite Renewables Initiative (LORI) Grants:

  Feasibility - $40,000, 15% cost share;
  Design - $125,000 or 75% of actual cost;
  Construction - $275,000 or 75% of actual cost

http://masstech.org/renewableenergy/large_renewables.htm

GRANTS, CONT.

- MTC Small Renewables Initiative (SRI) Rebate

  Maximum $50,000 for design and construction of renewable energy project, 10 kW maximum capacity. Rebates at $2.25/watt (AC) for wind and $4.00/watt (AC) for hydroelectric

http://masstech.org/renewableenergy/small_renewables.htm

COMMONWEALTH SOLAR INITIATIVE

$68 million over four years to install 27 MW solar electricity capacity

- Program starts January 23, 2008
- Can defray 30 – 50% of costs for businesses (project goal is 5-6 year payback or 10% rate of return on investment) up to $1,000,000
- Tiered rebate structure based on system's size
- Maximum size 500 kW

For more information, visit:
www.masstech.org/solar

Incentives

- List of for Incentives for Renewables & Efficiency (DSIRE - Database for State Incentives for Renewables & Efficiency)

  www.dsireusa.org/library/includes/map2.cfm?CurrentPageID=1&State=MA&RE=1&EE=1

  - Lists of available grants, rebates, exemptions from taxes, loans

Incentives, Cont.

- USDA Renewable Energy Systems and Energy Efficiency Improvement Program

  For commercial and agricultural sectors, grants of 25% of project cost up to $500,000; loans of 50% of project cost up to $10 million.

- Mass Energy – Renewable Energy Certificate (REC) Incentive

  Production incentive for PV - $0.06/kWh for 3 years purchased by Energy Consumers Alliances of New England. RECs also available for wind, small hydro and biomass.

REFERENCES

OTA Fact Sheet, “What You Should Know About Installing On-site Renewable Energy for Your Massachusetts Business”, January 2008
http://www.mass.gov/envir/ota/publications/pdf/renewable_energy_fact_sheet.pdf

Data Base for State Incentives for Renewables Energy and Efficiency (DSIRE)
http://dsireusa.org/library/includes/map2.cfm?CurrentPageID=1&State=MA&RE=1&EE=1

Division of Energy Resources (DOER), “A Developer’s Guide to Regulations, Policies and Programs that Affect Renewable Energy and Distributed Generation Facilities in Massachusetts”, April 2001
http://www.mass.gov/Eoca/docs/doer/pub_info/guidebook.pdf

US Department of Energy, Geothermal Technologies Program
http://www1.eere.energy.gov/geothermal/

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